

WHAT IS CLAIMED IS:

1. A nonaqueous electrolyte secondary battery comprising a positive electrode made of a carbonaceous material, an electrolyte containing a lithium salt, and a  
5 negative electrode made of metallic lithium or a material capable of occluding and releasing lithium,

wherein said positive electrode is formed from a boronized graphitic material containing boron or a boron compound such that the content of boron therein is 0.05-11  
10 wt%.

2. A nonaqueous electrolyte secondary battery as defined in Claim 1, wherein the positive electrode is formed from a silicon-containing boronized graphitic  
15 material containing silicon or a silicon compound such that the content of silicon therein is 0.01-5 wt%.

3. A method for production of a positive electrode material for a nonaqueous electrolyte secondary battery  
20 having a positive electrode made of a carbonaceous material, an electrolyte containing a lithium salt, and a negative electrode made of metallic lithium or a material capable of occluding and releasing lithium, comprising:

grinding at least one species, as said carbonaceous  
25 material for the positive electrode, selected from a graphitic material, an easily graphitizable carbonaceous material or a starting material thereof, and a carbon

precursor;

mixing the ground product with fine powder of boron or  
a boron compound and a binding component;

forming the mixture into shapes;

5 heating them in an inert gas atmosphere (for  
graphitization or carbonization); and

finally grinding the heat-treated shapes and  
classifying the ground particles.

10 4. A method for production of a positive electrode  
material of a nonaqueous electrolyte secondary battery as  
defined in Claim 3, further comprising:

incorporating the carbonaceous material for the  
positive electrode after its grinding with fine powder of  
15 silicon or a silicon compound, in addition to the fine  
powder of boron or a boron compound, and further  
incorporating the resulting mixture with a binding  
component;

forming the mixture into shapes;

20 heat-treating (for carbonization or graphitization)  
the shapes in an atmosphere of inert gas;

grinding the heat-treated shapes; and

finally classifying the resulting powder.

25 5. A method for production of a positive electrode  
material for the nonaqueous electrolyte secondary battery  
defined in Claim 3, wherein the positive electrode

material obtained by grinding and particle size classification has an average particle diameter of 10-60  $\mu\text{m}$  and also has a particle-size distribution such that particles having a particle diameter no larger than 5  $\mu\text{m}$  account for no more than 10% by volume of the entire positive electrode material.

6. A method for production of a positive electrode material for the nonaqueous electrolyte secondary battery defined in Claim 4, wherein the positive electrode material obtained by grinding and particle size classification has an average particle diameter of 10-60  $\mu\text{m}$  and also has a particle-size distribution such that particles having a particle diameter no larger than 5  $\mu\text{m}$  account for no more than 10% by volume of the entire positive electrode material.

7. A nonaqueous electrolyte secondary battery defined in any of Claims 1 to 6, wherein the boronized graphitic material meets the following requirements (a) and (b):

- (a) the carbonaceous material having the graphite crystal structure has the (002) plane such that the average interplaner spacing  $d(002)$  is no larger than 3.365 Å;
- (b) Raman spectroscopy with an argon ion laser beam having a wavelength of 5145 Å gives a peak (Pa) in the wavelength region of  $1580 \pm 100 \text{ cm}^{-1}$  and a peak (Pb) in the wavelength

region of  $1360 \pm 100 \text{ cm}^{-1}$ , with the peak (Pa) having a peak intensity (Ia) and the peak (Pb) having a peak intensity (Ib) such that the value of R defined as Value (R) =  $I_b/I_a$  is no smaller than 0.35.

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8. A nonaqueous electrolyte secondary battery defined in any of Claims 1 to 6 in which the positive electrode mix formed from said boronized graphitic material has a porosity of 0.2 to 0.6.

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9. A nonaqueous electrolyte secondary battery defined in any of Claim 7 in which the positive electrode mix formed from said boronized graphitic material has a porosity of 0.2 to 0.6.

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10. A nonaqueous electrolyte secondary battery having an electrode assembly which is arranged, together with a nonaqueous electrolyte containing a lithium salt, in a sealed container, said electrode assembly being composed of a positive electrode and a negative electrode which are laminated one over another with a separator interposed between them, said positive electrode being formed into a sheet from a positive electrode mix prepared mainly from the boronized graphitic material as defined in any of Claims 1 to 6, said negative electrode being formed into a sheet from a negative electrode mix prepared mainly from a carbonaceous material capable of occluding and releasing

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lithium, wherein the positive electrode and the negative electrode are arranged, with a separator interposed between them, in such a way that the periphery of the plane of the negative electrode facing to the positive electrode, said plane being projected to the plane of the positive electrode facing to the negative electrode, is surrounded by the periphery of the plane of the positive electrode facing to the negative electrode.

- 10 11. A nonaqueous electrolyte secondary battery having an electrode assembly which is arranged, together with a nonaqueous electrolyte containing a lithium salt, in a sealed container, said electrode assembly being composed of a positive electrode and a negative electrode which are
- 15 laminated one over another with a separator interposed between them, said positive electrode being formed into a sheet from a positive electrode mix prepared mainly from the boronized graphitic material as defined in Claim 7, said negative electrode being formed into a sheet from a
- 20 negative electrode mix prepared mainly from a carbonaceous material capable of occluding and releasing lithium, wherein the positive electrode and the negative electrode are arranged, with a separator interposed between them, in such a way that the periphery of the plane of the negative
- 25 electrode facing to the positive electrode, said plane being projected to the plane of the positive electrode facing to the negative electrode, is surrounded by the

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periphery of the plane of the positive electrode facing to the negative electrode.

12. A nonaqueous electrolyte secondary battery having  
5 an electrode assembly which is arranged, together with a nonaqueous electrolyte containing a lithium salt, in a sealed container, said electrode assembly being composed of a positive electrode and a negative electrode which are laminated one over another with a separator interposed  
10 between them, said positive electrode being formed into a sheet from a positive electrode mix prepared mainly from the boronized graphitic material as defined in Claim 8, said negative electrode being formed into a sheet from a negative electrode mix prepared mainly from a carbonaceous  
15 material capable of occluding and releasing lithium, wherein the positive electrode and the negative electrode are arranged, with a separator interposed between them, in such a way that the periphery of the plane of the negative electrode facing to the positive electrode, said plane  
20 being projected to the plane of the positive electrode facing to the negative electrode, is surrounded by the periphery of the plane of the positive electrode facing to the negative electrode.

25 13. A nonaqueous electrolyte secondary battery having an electrode assembly which is arranged, together with a nonaqueous electrolyte containing a lithium salt, in a

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sealed container, said electrode assembly being composed of a positive electrode and a negative electrode which are laminated one over another with a separator interposed between them, said positive electrode being formed into a sheet from a positive electrode mix prepared mainly from the boronized graphitic material as defined in Claim 9, said negative electrode being formed into a sheet from a negative electrode mix prepared mainly from a carbonaceous material capable of occluding and releasing lithium, wherein the positive electrode and the negative electrode are arranged, with a separator interposed between them, in such a way that the periphery of the plane of the negative electrode facing to the positive electrode, said plane being projected to the plane of the positive electrode facing to the negative electrode, is surrounded by the periphery of the plane of the positive electrode facing to the negative electrode.

14. A nonaqueous electrolyte secondary battery provided with a wound electrode assembly consisting of a beltlike positive electrode formed from a positive electrode mix composed mainly of the boronized graphitic material defined in any of Claims 1 to 6, a beltlike negative electrode formed from a negative electrode mix composed mainly of a carbonaceous material capable of occluding and releasing lithium, and a beltlike separator interposed between them, said positive electrode, said

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negative electrode, and said separator being spirally wound in their lengthwise direction,

wherein the negative electrode has a region within its innermost winding region and also has a first margin in  
5 the lengthwise direction facing to the inner periphery of the winding part such that it projects from the end at the innermost winding region of the negative electrode, and a second margin in the lengthwise direction facing to the outer periphery of the winding part such that it projects  
10 from the end at the outermost winding region of the negative electrode, and a third margin and a fourth margin are formed such that the ends in the widthwise direction of the positive electrode project from both ends positioned in the widthwise direction of the negative  
15 electrode over the entire region in the lengthwise direction of the negative electrode.

15. A nonaqueous electrolyte secondary battery provided with a wound electrode assembly consisting of a  
20 beltlike positive electrode formed from a positive electrode mix composed mainly of the boronized graphitic material defined in Claim 7, a beltlike negative electrode formed from a negative electrode mix composed mainly of a carbonaceous material capable of occluding and releasing  
25 lithium, and a beltlike separator interposed between them, said positive electrode, said negative electrode, and said separator being spirally wound in their lengthwise



direction,

wherein the negative electrode has a region within its innermost winding region and also has a first margin in the lengthwise direction facing to the inner periphery of the winding part such that it projects from the end at the innermost winding region of the negative electrode, and a second margin in the lengthwise direction facing to the outer periphery of the winding part such that it projects from the end at the outermost winding region of the negative electrode, and a third margin and a fourth margin are formed such that the ends in the widthwise direction of the positive electrode project from both ends positioned in the widthwise direction of the negative electrode over the entire region in the lengthwise direction of the negative electrode.

16. A nonaqueous electrolyte secondary battery provided with a wound electrode assembly consisting of a beltlike positive electrode formed from a positive electrode mix composed mainly of the boronized graphitic material defined in Claim 8, a beltlike negative electrode formed from a negative electrode mix composed mainly of a carbonaceous material capable of occluding and releasing lithium, and a beltlike separator interposed between them, said positive electrode, said negative electrode, and said separator being spirally wound in their lengthwise direction,

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wherein the negative electrode has a region within its innermost winding region and also has a first margin in the lengthwise direction facing to the inner periphery of the winding part such that it projects from the end at the innermost winding region of the negative electrode, and a second margin in the lengthwise direction facing to the outer periphery of the winding part such that it projects from the end at the outermost winding region of the negative electrode, and a third margin and a fourth margin are formed such that the ends in the widthwise direction of the positive electrode project from both ends positioned in the widthwise direction of the negative electrode over the entire region in the lengthwise direction of the negative electrode.

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17. A nonaqueous electrolyte secondary battery provided with a wound electrode assembly consisting of a beltlike positive electrode formed from a positive electrode mix composed mainly of the boronized graphitic material defined in Claim 9, a beltlike negative electrode formed from a negative electrode mix composed mainly of a carbonaceous material capable of occluding and releasing lithium, and a beltlike separator interposed between them, said positive electrode, said negative electrode, and said separator being spirally wound in their lengthwise direction,

wherein the negative electrode has a region within its

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innermost winding region and also has a first margin in the lengthwise direction facing to the inner periphery of the winding part such that it projects from the end at the innermost winding region of the negative electrode, and a  
5 second margin in the lengthwise direction facing to the outer periphery of the winding part such that it projects from the end at the outermost winding region of the negative electrode, and a third margin and a fourth margin are formed such that the ends in the widthwise direction  
10 of the positive electrode project from both ends positioned in the widthwise direction of the negative electrode over the entire region in the lengthwise direction of the negative electrode.